554 — 9:30

TUNING OF MT CELLS TO VELOCITY GRADIENTS S. Treue and R. A. Andersen Massachusetts Institute of Technology, Cambridge MA, USA

Purpose. Relative motion is an important cue for the extraction of depth in the perception of structure from motion and the recovery of depth from optical flow. To a first approximation such motion fields can be described as mosaics of linear velocity gradients. To investigate the processing of such motion fields we developed random dot patterns forming linear gradients. Methods. The gradients are characterized by the angle between the direction of motion of the pattern and the direction of the steepest ascend of the gradient. If the ascend is in (against) the direction of motion the resulting gradient will be stretching (compressing) while a right angle between the direction of motion and the gradient angle will result in a shearing gradient. Intermediate angles represent different types of deformation. Neural responses to linear gradients of equal slope were plotted in a polar coordinate system in which the polar angle represents the gradient direction and the distance from the origin represents the firing rate. We determined the response of area MT neurons in the awake, behaving monkey to 8 such velocity gradients. The patterns moved in the cells' preferred direction behind a stationary aperture centered on and contained well within the classical receptive field of each neuron. The average speed of all gradients was equal to the cells' preferred speed.
Results. About one third of the MT cells recorded responded significantly stronger to at least one of the gradients used than to a flat velocity profile moving at the cell's preferred speed. All of these cells also showed a systematic single-lobed tuning curve in the polar plot. Conclusions. We propose that these cells could form the basis for extracting structure from motion by their ability to respond selectively to velocity gradients. These cells might also be used to generate the expansion/contraction and rotation selective cells in area MST.

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None.

This needs an info-theory approach

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FORM AND COLOR ARE NOT SEGREGATED IN MONKEY STRIATE CORTEX A.G. Leventhal, K.G. Thompson, D. Liu, L.M. Neuman and S.J. Ault University of Utah, Department of Anatomy, 50 North Medical Drive, Salt Lake City, UT 84132

We studied the orientation and color sensitivity of cells in layers II and III of rhesus monkey striate cortex. Cells studied subserved regions of retina from 3 to 15 degrees from the center of the fovea. Electrode tracts were reconstructed and were approximately parallel to the pial surface. Cells were studied at 75 to 100 μm intervals using quantitative procedures that allowed on-line statistical analyses of responses to a variety of achromatic and chromatic visual stimuli. For each cell, orientation sensitivity, direction sensitivity, color sensitivity, spatial frequency tuning and center surround organization were determined. The results indicate that virtually all cells (95%) in layers II and III exhibit statistically significant orientation preferences (biases). The degree of orientation bias varies continuously among cells. Most cells in the upper layers of area 17 also exhibit color sensitivity. The degree of color sensitivity also varies among cells. The unimodal distribution of the orientation biases of color sensitive cells did not differ from the unimodal distribution of the orientation biases of the broad-band (non-color sensitive) cells. We could find no evidence of clusters of oriented cells that were insensitive to color nor any evidence of clusters of color sensitive cells that were insensitive to orientation. We found no evidence of discrete regions in layers II and III having relatively high (suggesting parvocellular LGNd influence) and low (suggesting magnocellular LGNd influence) optimal spatial frequencies [Dreher *et al.*, (1976) *J. Physiol* **258:** 433-452; Kaplan, and Shapley, (1982) *J. Physiol* **330**: 125-143] Preliminary studies employing cytochrome oxidase staining reveal poorly demarcated light and dark regions which do not correlate with color or orientation sensitivity. Our results are inconsistent with the hypothesis that primate area 17 contains regions specialized for the detection of color and other regions specialized for the detection of orientation [Livingstone and Hubel (1988) *Science* ~~240:740-749~~]. ~~Supported by~~ NIH EY04951; EY08523.

556 — 10:00

FUNCTIONAL DISSOCIATION OF PARALLEL VISUAL STREAMS IN THE MACAQUE TEMPORAL LOBE. C.E. Schroeder, A. Mehta, S.J. Givre & M. Steinschneider, *Neuroscience and Neurology Departments, Albert Einstein College of Medicine, Bronx, NY.*

We investigated the organization of the temporal lobe visual pathways by measuring the timing and wavelength sensitivity of luminance-evoked activity in visual areas adjoining the superior temporal sulcus (STS) in 2 awake macaques. Local postsynaptic potential and action potential patterns were assessed by sampling laminar current source density and multiunit activity profiles with multicontact electrodes that spanned all cortical laminae at each recording site. Visual areas were located and distinguished on-line by their relative positions, field potential characteristics and degree of polysensory responsiveness; recording sites were reconstructed histologically. Response latencies showed a systematic increase beginning in Area MT - mean=20.2 ms, SD=1.8 ms and extending anteriorly along the upper bank of STS: Posterior upper STS (including MST and posterior portions of FST and STP) - mean=26.0 ms, SD=3.7 ms; Anterior upper STS (including anterior portions of FST and STP) - mean=34.27 ms, SD=4.8 ms. This is consistent with serial organization of processing in these areas. In lower STS no such latency trend was evident, but as a whole, latencies (mean=50.3, SD=5.2) were distinct from even the longest ones in (anterior) upper STS. As shown earlier, there was substantial wavelength sensitivity in IT (lower STS), but MT and upper STS areas (including FST, MST and STP), showed little evidence of wavelength sensitivity. These findings indicate a fast, wavelength-insensitive stream in the upper bank of STS and a slower, wavelength-sensitive stream in the lower bank of STS. Based on timing and wavelength sensitivity these streams may be driven by the magno- and parvo- systems respectively.

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557 — 10:15

Mapping of the human visual cortex utilizing functional magnetic resonance imaging (FMRI) D.L. Miller, E.A. DeYoe, J. Neitz, P.A. Bandettini, J.S. Hyde — Medical College of Wisconsin, Milwaukee, WI.

Purpose FMRI was used to study the retinotopic organization of the human visual cortex. Visually-evoked activation of visual cortex was also used to assess the spatial and temporal resolution of FMRI.

Method FMRI of event-related changes in blood oxygenation was used to record the spatial and temporal pattern of brain activation during visual stimulation of two human Ss. Flickering (8 Hz) checkered annuli centered about a fixation point were presented monocularly in Maxwellian view with a computer-controlled liquid crystal display. Annulus radius, width and check size was scaled by eccentricity. Stimuli were presented for either 10 or 20 sec alternating with darkness for up to 6 cycles.

Results For the smallest annuli (0°-1°) activation was limited to the occipital pole. Increasing annulus diameter activated more anterior portions of the calcarine cortex with sparing of the occipital pole at the largest diameter (10°-30°). Although rise-time of the FMRI signal from onset to 90% of peak was 7-8 sec, differences as small as 1-2 seconds could be reliably detected.

Conclusions FMRI is capable of resolving spatial differences in activation consistent with cortical retinotopy. It can also resolve temporal changes in activation during tasks involving cerebral activation persisting for at least 1-2 sec. Furthermore, FMRI permits virtually unlimited repeated measures within single subjects. These advantages are essential for further resolution of the spatial and temporal aspects of visual information processing.

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None

558 — 10:30

LOCALIZATION OF VISUAL FUNCTIONS AND VEP SIGNALS WITH FUNCTIONAL MRI K.K. Kwong, C.E. Stern, J.R. Baker, J.W. Belliveau, R.B.H.Tootell, H-M. Cheng, B.R. Rosen Harvard Medical School and MGH-NMR Center , Charlestown, MA 02129

Purpose: Use functional MRI (Kwong et al. PNAS, June 1992) to identify and localize the underlying neuroanatomical location and distribution of visual-evoked-potential (VEP) signal changes. **Method:** Functional MRI (echo planar gradient echo: TR=1000ms, TE=50ms, up to 1024 images collected sequentially) was used to obtain temporal and spatial frequency responses to goggle and checkerboard stimuli. Using 6 volunteers, functional MRI studies have examined binocularity with goggles, stereopsis with random dot stereogram and motion with flickering vs. moving stimuli. **Results:** For both VEP and functional MRI, temporal frequency response peaked between 8 and 12 Hz and spatial frequency response peaked around 20 min of arc. Both MR and VEP showed that binocular responses were larger than monocular responses. For binocularity and motion tests, MR also demonstrated blood flow change at extrastriate higher visual function centers in addition to V1. **Conclusion**: Functional MRI localizes specific visual functions in V1 as well as higher order visual areas.

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None

559 — 10:45

Mapping Human Visual Cortex: Evidence from Functional MRI and Histology. R.B.H. Tootell[1], K.K. Kwong[2], J.W. Belliveau[2], J.R. Baker[2], C.E. Stern[2], S.J. Hockfield[3], H. Breiter[2], R. Born[1], R. Benson[2], T.J. Brady [2] and B.R. Rosen[2] Harvard Med. School[1], Boston MA 02129; MGH-NMR Center[2], 149 13th St., Charlestown, MA 02129; Yale U. School of Medicine[3], New Haven, Conn. 06510

Recent technical advances have yielded a wealth of information that was unavailable to early cytoarchitonic anatomists. Here we test the hypothesis that human visual cortex is largely homologous to macaque visual cortex. We compared human autopsy material with the Old World macaque and green monkeys in regards to staining for CAT-301, cytochrome oxidase, and/or myelin. Using functional MRI (fMRI), we also have been able to compare the topography and functional activity of human visual cortex to previous studies of macaque visual cortex that employed 2-deoxyglucose labeling, optical recording and/or single unit recording.

fMRI maps were obtained using a 1.5 T GE scanner with EPI, while normal subjects viewed specific visual stimuli. Stimulus variables included retinotopy, color, and motion. All stimuli activated striate and extrastriate cortex. Maps of extrastriate activity were stimulus-dependent. One prominent extrastriate region activated by moving stimuli is consistent with PET reports of an MT (V5) homologue (Zeki et al., 1992).

Cytochrome oxidase (CO) staining showed an oval (~1 X 1.5 cm) region of dark patches in layers 1-4, ~8 cm anterior to foveal V1: similar CO staining patterns exist in MT/V5 of macaque, green and owl monkeys. CAT-301 and myelin staining also are consistent with a human MT homologue. In addition, the CO staining topography shows dark patches anterior to dorsal V2: similar CO staining patterns are seen in presumptive V3/V3A of the green monkey. Presumably, this and future studies will greatly clarify the organization of human visual cortex.

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None